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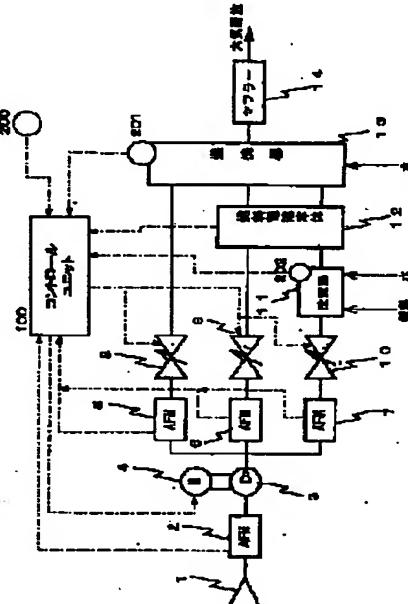
(54) FUEL CELL SYSTEM

(57) Abstract:

PROBLEM TO BE SOLVED: To provide a fuel cell system capable of shortening a start-up time, even if the air flow control means is frozen or fixed.

SOLUTION: There are provided a fuel cell body 12, which generates power from the reformed gas generated by a reformer 11 and the air supplied from an air supply means, a combustor 13 which catalytically combusts the gas exhausted from the fuel cell body 12 by receiving the air from the air supply means, and flow control valves 8-10 which control the flow rate of the air supplied to the reformer 11, the fuel cell body 12, and the combustor 13 by the air supply means, by changing the opening degree of a flow channel. To stop the power generation of the fuel cell body 12, the flow control valves 8-10 are closed immediately after power generation is stopped, and then the flow control valve 8-10 are opened, when a prescribed condition is established.

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CLAIMS

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## [Claim(s)]

[Claim 1] a original fuel -- the bottom of a reforming catalyst -- a reforming reaction -- hydrogen -- with a fuel reforming means to generate rich reformed gas A generation-of-electrical-energy means to generate electricity from the reformed gas which this fuel reforming means generated, and the air supplied from an air supply means, The combustion means which carries out catalyzed combustion of the exhaust gas which a generation-of-electrical-energy means discharges in response to supply of air from an air supply means, In case an air supply means suspends a generation of electrical energy of an air control-of-flow means to change the opening of passage and to control the flow rate of the air supplied to a fuel reforming means, a generation-of-electrical-energy means, and a combustion means, and said generation-of-electrical-energy means The fuel cell system characterized by having a generation-of-electrical-energy halt tense means to make an air control-of-flow means open when said air control-of-flow means is closed immediately after a generation-of-electrical-energy halt and predetermined conditions are satisfied after that.

[Claim 2] A generation-of-electrical-energy means to generate electricity from the hydrogen gas which a hydrogen storage means supplies, and the air supplied from an air supply means, The combustion means which carries out catalyzed combustion of the exhaust gas which a generation-of-electrical-energy means discharges in response to supply of air from an air supply means, In case an air supply means suspends a generation of electrical energy of an air control-of-flow means to change the opening of passage and to control the flow rate of the air supplied to a fuel reforming means, a generation-of-electrical-energy means, and a combustion means, and said generation-of-electrical-energy means The fuel cell system characterized by having a generation-of-electrical-energy halt tense means to make an air control-of-flow means open when said air control-of-flow means is closed immediately after a generation-of-electrical-energy halt and predetermined conditions are satisfied after that.

[Claim 3] Said generation-of-electrical-energy halt tense means is a fuel cell system according to claim 1 or 2 characterized by judging formation of predetermined conditions since time amount until it falls to the temperature to which a catalyst will not react after a generation-of-electrical-energy halt passed.

[Claim 4] Said generation-of-electrical-energy halt tense means is a fuel cell system according to claim 1 or 2 characterized by lengthening the clausium period of an air control-of-flow means, so that the amount of generations of electrical energy in the generation-of-electrical-energy means within the time amount in front of a generation-of-electrical-energy halt set up beforehand is large.

[Claim 5] Said generation-of-electrical-energy halt tense means is a fuel cell system according to claim 1 or 2 characterized by opening the above-mentioned flow rate control means for said temperature which has a detection means to detect one [ at least ] temperature among a fuel reforming means and a combustion means, and was detected after the generation-of-electrical-energy halt having fallen to the predetermined value as formation of predetermined conditions.

[Claim 6] Formation of said predetermined conditions is a fuel cell system according to claim 5 characterized by the detection temperature of a temperature detection means being the temperature which catalytic reaction stops.

[Claim 7] Said temperature detection means is a fuel cell system according to claim 5 characterized by detecting the temperature of the reforming catalyst of said fuel reforming means, or the combustion catalyst of a combustion means.

[Claim 8] Said temperature detection means is a fuel cell system according to claim 5 characterized by presuming the temperature of a catalyst based on the temperature of the air in a catalyst, or combustion gas.

[Claim 9] Said temperature detection means is a fuel cell system according to claim 5 characterized by detecting the temperature of the refrigerant of the heat exchanger of a catalyst and presuming the temperature of a catalyst based on the temperature of this refrigerant.

[Claim 10] Said temperature detection means is a fuel cell system according to claim 5 which detects the container temperature of a catalyst and is characterized by presuming the temperature of a catalyst based on the detected temperature.

[Claim 11] Said generation-of-electrical-energy halt tense means is a fuel cell system according to claim 1 or 2 characterized by having an opening setting means to set up the opening which makes an air control-of-flow means open after predetermined condition formation according to an air flow rate required at the time of a system startup.

[Claim 12] Said opening setting means is a fuel cell system according to claim 11 characterized by setting it as the value which passes an air flow rate required for power generating which the auxiliary machinery drive of an automobile takes the opening of an air control-of-flow means in maintenance and the generation-of-electrical-energy means of temperature which said catalyst reacts.

[Claim 13] Said opening setting means is a fuel cell system according to claim 11 or 12 which has an OAT detection means to detect an OAT, and is characterized by setting up greatly the opening of said air control-of-flow means, so that the OAT at the time of a generation-of-electrical-energy halt is low.

[Claim 14] Said air control-of-flow means is a fuel cell system according to claim 1 or 2 characterized by having a freezing detection means to maintain the opening set up after the generation-of-electrical-energy halt when freezing is detected at the time of a system startup.

[Claim 15] Said air control-of-flow means is a fuel cell system according to claim 14 characterized by usually shifting control of opening to the control at the time of operation when freezing is not detected at the time of a system startup, or when a freezing condition is solved.

[Claim 16] Said freezing detection means is a fuel cell system according to claim 14 characterized by detecting the existence of freezing of an air control-of-flow means by having an opening detection means to detect the opening of a valve, and measuring the opening of the air control-of-flow means detected by the command value and opening detection means to an air control-of-flow means.

[Claim 17] Said freezing detection means is a fuel cell system according to claim 14 characterized by detecting the existence of freezing of an air control-of-flow means by having a current detection means to detect the current supplied to an air control-of-flow means, and comparing the command value to this air control-of-flow means with the current value detected by the current detection means.

[Claim 18] Said freezing detection means is a fuel cell system according to claim 16 or 17 characterized by ordering it at least two kinds of different opening command values.

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[Translation done.]

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**DETAILED DESCRIPTION**

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**[Detailed Description of the Invention]****[0001]**

[Field of the Invention] This invention relates to amelioration of a vehicle use fuel cell system.

**[0002]**

[Description of the Prior Art] A fuel cell system is left in a low-temperature ambient atmosphere 0 degree C or less in a idle state, and when an air control-of-flow means (bulb) freezes with the moisture contained in air and it fixes, after dissolving ice at the time of starting, it is necessary to make an air control-of-flow means into flight readiness. As this means, the method (JP,2000-12060,A, JP,5-131131,A) of raising the temperature of a system etc. is conventionally proposed by the elevated-temperature gas supplied using the compressor which is an air supply means.

**[0003]**

[Problem(s) to be Solved by the Invention] However, since the approach of raising the temperature of a system with the elevated temperature air supplied from an air supply means like the above-mentioned conventional example, and thawing an air control-of-flow means required time amount by the dissolution of ice, it had the problem that system warm-up time became long.

[0004] Moreover, there is also a problem that system warm-up time becomes long further in order not to spread round the equipment with which the air supplied from an air supply means when it freezes in order that an air control-of-flow means may usually maintain a close-by-pass-bulb-completely condition at the time of a generation-of-electrical-energy halt, and it fixes is located down-stream from an air control-of-flow means.

[0005] Moreover, although the approach of generally dissolving ice using a heater or an electric heater was also considered, a system turns complicated up in this case, and attached energy, such as a dc-battery, needed to be used.

[0006] Then, this invention was made in view of the above-mentioned trouble, and aims at offering the fuel cell system which can shorten warm-up time at the time of freezing and fixing of an air control-of-flow means.

**[0007]**

[Means for Solving the Problem] the 1st invention -- a original fuel -- the bottom of a reforming catalyst -- a reforming reaction -- hydrogen -- with a fuel reforming means to generate rich reformed gas A generation-of-electrical-energy means to generate electricity from the reformed gas which this fuel reforming means generated, and the air supplied from an air supply means, The combustion means which carries out catalyzed combustion of the exhaust gas which a generation-of-electrical-energy means discharges in response to supply of air from an air supply means, In case an air supply means suspends a generation of electrical energy of an air control-of-flow means to change the opening of passage and to control the flow rate of the air supplied to a fuel reforming means, a generation-of-electrical-energy means, and a combustion means, and said generation-of-electrical-energy means If said air control-of-flow means is closed immediately after a generation-of-electrical-energy halt and predetermined conditions are satisfied after that, it will have a generation-of-electrical-energy halt tense

means to make an air control-of-flow means open.

[0008] Moreover, a generation-of-electrical-energy means to generate electricity from the hydrogen gas with which a hydrogen storage means supplies the 2nd invention, and the air supplied from an air supply means, The combustion means which carries out catalyzed combustion of the exhaust gas which a generation-of-electrical-energy means discharges in response to supply of air from an air supply means, In case an air supply means suspends a generation of electrical energy of an air control-of-flow means to change the opening of passage and to control the flow rate of the air supplied to a fuel reforming means, a generation-of-electrical-energy means, and a combustion means, and said generation-of-electrical-energy means If said air control-of-flow means is closed immediately after a generation-of-electrical-energy halt and predetermined conditions are satisfied after that, it will have a generation-of-electrical-energy halt tense means to make an air control-of-flow means open.

[0009] Moreover, as for the 3rd invention, in said 1st or 2nd invention, since time amount until a catalyst falls to the temperature which will not react passed after the generation-of-electrical-energy halt, said generation-of-electrical-energy halt tense means judges formation of predetermined conditions.

[0010] In addition, said catalyst has at least one side of a fuel reforming means and a combustion means.

[0011] Moreover, the 4th invention is set to said 1st or 2nd invention, and said generation-of-electrical-energy halt tense means lengthens the clausilium period of an air control-of-flow means, so that the amount of generations of electrical energy in the generation-of-electrical-energy means within the time amount in front of a generation-of-electrical-energy halt set up beforehand is large.

[0012] Moreover, the temperature which said generation-of-electrical-energy halt tense means has a detection means to detect one [ at least ] temperature among a fuel reforming means and a combustion means, in said 1st or 2nd invention, and the 5th invention detected after the generation-of-electrical-energy halt opens the above-mentioned flow rate control means for having fallen to the predetermined value as formation of predetermined conditions.

[0013] Moreover, the 6th invention is temperature to which the catalytic reaction of a fuel reforming means and a combustion means stops [ the detection temperature of a temperature detection means ] formation of said predetermined conditions in said 5th invention.

[0014] Moreover, as for said temperature detection means, the 7th invention detects the temperature of the reforming catalyst of said fuel reforming means, or the combustion catalyst of a combustion means in said 5th invention.

[0015] Moreover, the 8th invention presumes the temperature of a catalyst in said 5th invention based on the temperature of air [ in / in said temperature detection means / a catalyst ], or combustion gas.

[0016] Moreover, in said 5th invention, said temperature detection means detects the temperature of the refrigerant of the heat exchanger of a catalyst, and the 9th invention presumes the temperature of a catalyst based on the temperature of this refrigerant.

[0017] Moreover, the 10th invention presumes the temperature of a catalyst in said 5th invention based on the temperature which said temperature detection means detected the container temperature of a catalyst, and was detected.

[0018] Moreover, the 11th invention has an opening setting means by which said generation-of-electrical-energy halt tense means sets up the opening which makes an air control-of-flow means open after predetermined condition formation according to an air flow rate required at the time of a system startup, in said 1st or 2nd invention.

[0019] Moreover, the 12th invention sets said opening setting means as the value which passes an air flow rate required for power generating which the auxiliary machinery drive of an automobile takes the opening of an air control-of-flow means in maintenance and the generation-of-electrical-energy means of temperature which said catalyst reacts in said 11th invention.

[0020] Moreover, in said 11th or 12th invention, said opening setting means has an OAT detection means to detect an OAT, and the 13th invention sets up greatly the opening of said air control-of-flow means, so that the OAT at the time of a generation-of-electrical-energy halt is low.

[0021] Moreover, the 14th invention has a freezing detection means by which said air control-of-flow

means maintains the opening set up after the generation-of-electrical-energy halt when freezing is detected at the time of a system startup, in said 1st or 2nd invention.

[0022] Moreover, said air control-of-flow means usually shifts control of opening to the control at the time of operation, when freezing is not detected in said 14th invention at the time of a system startup, or when, as for the 15th invention, a freezing condition is solved.

[0023] Moreover, in said 14th invention, said freezing detection means has an opening detection means to detect the opening of a valve, and the 16th invention detects the existence of freezing of an air control-of-flow means the command value to an air control-of-flow means, and by measuring the opening of the air control-of-flow means detected by the opening detection means.

[0024] Moreover, in said 14th invention, said freezing detection means has a current detection means to detect the current supplied to an air control-of-flow means, and the 17th invention detects the existence of freezing of an air control-of-flow means by comparing the command value to this air control-of-flow means with the current value detected by the current detection means.

[0025] Moreover, in the 18th invention, in said 16th or 17th invention, said freezing detection means orders it at least two kinds of different opening command values.

[0026]

[Effect of the Invention] Therefore, according to the 1st or 2nd invention, since an air control-of-flow means is closed immediately after a generation-of-electrical-energy halt, supply of the air to a fuel reforming means and a generation-of-electrical-energy means can be intercepted, catalytic reaction can stop, and the whole system can be suspended certainly.

[0027] Then, if predetermined conditions are satisfied, since the air control-of-flow means will be opened, the passage of air is secured also when a flow rate control means froze and fixes after a generation-of-electrical-energy halt. By this valve opening, at the time of next starting, it is not concerned with the existence of freezing but starting of a system is attained for a short time.

[0028] Moreover, by considering as time amount until the catalyst searched for in the experiment etc. in advance will not react, the 3rd invention does not have the increasing-newly-sensor etc. need, and can constitute equipment simply.

[0029] Moreover, since the temperature of a catalyst (a fuel reforming means and combustion means) also becomes an elevated temperature when the 4th invention has the large amount of generations of electrical energy in a generation-of-electrical-energy means, Since time amount until it opens an air control-of-flow means is lengthened when the amount of generations of electrical energy of the generation-of-electrical-energy means in the time amount beforehand set up in front of the generation-of-electrical-energy halt is large, while the catalyst of a fuel reforming means and a combustion means is the temperature which still reacts, it can prevent opening an air control-of-flow means.

[0030] Moreover, since according to the 5th invention an air control-of-flow means can be opened after one [ at least ] detection temperature falls to a predetermined value among a fuel reforming means and a combustion means, precise control can be performed.

[0031] Moreover, since predetermined temperature to which the 6th invention opens an air control-of-flow means is made into the temperature to which a catalyst (a fuel reforming means and combustion means) will not react, even if air flows after opening an air control-of-flow means, a fuel cell system can be suspended certainly.

[0032] Moreover, the 7th invention is detecting the temperature of the reforming catalyst of a fuel reforming means, or the combustion catalyst of a combustion means, and can judge formation of predetermined conditions.

[0033] Moreover, the 8th invention carries out direct detection of the temperature of the reformed gas in a fuel reforming means and a combustion means, and combustion gas, and formation of predetermined conditions can be judged by presuming the temperature of a catalyst from this temperature.

[0034] Moreover, the 9th invention is detecting the coolant temperature of the heat exchanger of catalysts, such as a fuel reforming means and a combustion means, and can judge formation of predetermined conditions. Rather than the temperature of a catalyst, since especially a coolant temperature is low temperature, it can detect temperature with a simple detection means.

[0035] Moreover, the 10th invention is detecting the temperature of the container in a catalyst (a fuel reforming means and combustion means), and can judge formation of predetermined conditions. Temperature can be detected by the simple approach, without adding a major change to the body of a container etc., in order to detect the temperature on the front face of a container especially.

[0036] Moreover, in case an air control-of-flow means is made to open after the above-mentioned predetermined condition formation according to the 11th or 12th invention By controlling to become the opening which can maintain the reaction of the catalyst of a fuel reforming means and a combustion means, and can generate power required to drive each auxiliary machinery of an automobile with a generation-of-electrical-energy means Since the passage of the air which an air supply means supplies is securable even if it is the case where the air control-of-flow means has frozen and fixed at the time of a next system startup, a fuel cell system can be started certainly and the upper-frozen flow rate control means can be thawed.

[0037] Moreover, since the 13th invention sets up the opening of an air control-of-flow means greatly so that the outside air temperature at the time of a system stop is low, even when the air control-of-flow means has frozen at the time of a next system startup, it can start a system in a short time, and can also make prompt the dissolution of the frozen air control-of-flow means.

[0038] Moreover, the 14th invention can avoid that an air control-of-flow means moves by force the air control-of-flow means which froze and fixed in order to maintain the opening set up after the system stop last time, when it has a freezing detection means and freezing is detected at the time of starting.

[0039] Moreover, since it usually returns to the control at the time of operation when freezing of an air control-of-flow means dissolves according to the 15th invention, a fuel reforming means and a generation-of-electrical-energy means can perform an efficient reforming reaction and an efficient generation of electrical energy.

[0040] Moreover, the 16th invention can check the existence of freezing by an air control-of-flow means' having an opening detection means, and measuring the opening command value inputted and the opening at that time.

[0041] Moreover, the 17th invention can check the existence of freezing by an air control-of-flow means' having a current detection means, and comparing the opening command value inputted with the current at that time.

[0042] Moreover, according to the 18th invention, since few command values of a freezing detection means carry out freezing detection with two kinds of different command values even if there are per detection actuation, even when the opening of a flow rate control means and the opening of one command value are the same, they can ensure freezing detection with other command values.

[0043]

[Embodiment of the Invention] Hereafter, 1 operation gestalt of this invention is explained based on an accompanying drawing.

[0044] Drawing 1 is the outline block diagram showing the gestalt of operation of the 1st of this invention.

[0045] Drawing 1 -- setting -- 1 -- an air filter, 2, and 5-7 -- an air flow meter and 3 -- for a flow control valve and 11, as for the body of a fuel cell, and 13, a reforming machine and 12 are [ a compressor drive motor, and 8-10 / a compressor and 4 / a combustor and 14 ] mufflers (silencer).

[0046] Moreover, in Drawing 1, the compressor drive motor 4 constitutes an air supply means from an air filter 1, and an air flow meter 5, the 8 air flow meter flow control valve 6, the 9 air flow meter flow control valve 7, and a flow control valve 10 constitute an air control-of-flow means for each.

[0047] The reforming machine (fuel reforming means) 11 which performs reforming of a original fuel is formed in the lower stream of a river of a flow control valve 10, and the body 12 of a fuel cell as a generation-of-electrical-energy means is arranged in the lower stream of a river of this reforming machine 11 and a flow control valve 9.

[0048] And the combustor 13 as a combustion means is formed in the lower stream of a river of the body 12 of a fuel cell, and a flow control valve 8, and atmospheric-air disconnection of the exhaust air generated with the combustor 13 is carried out through a muffler 14.

[0049] The air supply means is controlling the compressor drive motor 4 so that the discharge quantity of a compressor 3 turns into a desired flow rate in the air by which clarification was carried out with the air filter 1, after an air flow meter 5 detects a flow rate.

[0050] The air control-of-flow means is formed in the passage to the reforming machine 11, the body 12 of a fuel cell, and a combustor 13 at each, it changes the opening of flow control valves 8, 9, and 10 so that it may become a desired downstream flow rate from the flow rate detected with air flow meters 5, 6, and 7, and it is controlling the air flow rate supplied to the reforming machine 11, the body 12 of a fuel cell, and a combustor 13.

[0051] The reforming machine 11 generates the mixed gas of a lifting, and H<sub>2</sub> and CO for a reforming reaction in a reforming catalyst using the air supplied from hydrocarbon system fuels (original fuel), water, and air supply means, such as a methanol and a gasoline, from the tank which is not illustrated. the reforming machine 11 since CO carries out poisoning of the platinum electrode of the body 12 of a fuel cell and the engine performance of the body of a fuel cell is reduced remarkably -- means, such as a selective oxidation reaction, -- using -- CO removal in mixed gas -- carrying out -- hydrogen -- it also has equipment which generates rich reformed gas.

[0052] The body 12 of a fuel cell generates electricity by reacting with the air which the reformed gas generated with the reforming vessel 11 is supplied by the fuel electrode, and is supplied from an air supply means.

[0053] A combustor 13 oxidizes with a catalyst the reformed gas and air after the reaction discharged from the body 12 of a fuel cell, and is changed to matter, such as a steam in which emission to atmospheric air is possible.

[0054] Flow control valves 8-10 are controlled by the control unit 100. A control unit 100 determines and drives the opening of each flow control valves 8, 9, and 10 based on an air flow rate, the amount of generations of electrical energy of the body 12 of a fuel cell, etc. which the OAT which the temperature sensor 200 detected, the temperature of the combustor which the temperature sensor 201 detected, the temperature of the reforming machine 11 which the temperature sensor 202 detected, and air flow meters 2, 5, 6, and 7 detected.

[0055] The flow chart of drawing 2 shows an example of the flow-control-valve control performed by the control unit 100, and is performed at the time of a halt of a fuel cell system.

[0056] First, processing of a generation-of-electrical-energy halt is started by the input of a generation-of-electrical-energy stop signal etc. at step S1.

[0057] At step S2, in order to stop the air supply to the reforming machine 11, a fuel cell 12, and a combustor 13 and to suspend each reaction, clausilium of the flow control valves 8, 9, and 10 is carried out, respectively.

[0058] Next, at step S3, it judges whether the temperature to which the catalyst of the reforming machine 11 and a combustor 13 will not react was reached (formation of predetermined conditions).

[0059] Detection of the temperature which the reaction of these catalysts stops can use the temperature which the above-mentioned temperature sensors 201 and 202 detected, if the temperature which temperature sensors 201 and 202 detected becomes below a predetermined value, respectively, will be judged that catalytic reaction stopped and will progress to processing of step S4.

[0060] As decision of this catalytic-reaction halt, although direct detection of the temperature of a catalyst is carried out as mentioned above, you may carry out based on others and the value detected or presumed indirectly.

[0061] For example, drawing 3 shows the time amount to until the catalyst of the reforming machine 11 or a combustor 13 suspends a reaction from a generation-of-electrical-energy halt, and the relation of whenever [ catalyst temperature ]. The elapsed time to which can become below the temperature T<sub>0</sub> to which a catalyst will not react is computed from this graph etc. based on the temperature of the detected reforming machine 11 or a combustor 13. In this case, at step S3, when it supervises by a timer etc. that time amount to passes and this elapsed time to passes it, it considers that catalytic reaction stopped and progresses to processing of step S4.

[0062] Or drawing 4 shows the relation of whenever [ catalyst temperature / of the amount W of

generations of electrical energy in the body 12 of a fuel cell within the time amount beforehand decided on in front of the generation-of-electrical-energy halt, the reforming machine 11, and a combustor 13 ]. [0063] In this case, To is decided whenever [ catalyst temperature ] from the amount W of generations of electrical energy of the detected body 12 of a fuel cell, and the time amount to according to To is found whenever [ catalyst temperature ] from the graph of above-mentioned drawing 4 , and at step S3, when it supervises by a timer etc. that time amount to passes and this elapsed time to passes it, it considers that catalytic reaction stopped and progresses to processing of step S4. Thereby, it can control, without carrying out direct detection of the temperature of the reforming machine 11 or a combustor 13. In addition, the period (time amount) which is made to carry out clausilium of the flow control valve, and waits for a halt of catalytic reaction becomes long, so that the amount of generations of electrical energy within the time amount in front of a generation-of-electrical-energy halt set up beforehand is large.

[0064] In addition, a temperature sensor 202 detects the reformed gas temperature in the reforming machine 11, you may make it a temperature sensor 201 detect the temperature of the combustion gas in a combustor 13, and the temperature of a catalyst is presumed in this case using the relation of To the temperature Tg of each detected gas as shown in drawing 5 , and whenever [ catalyst temperature ]. And when the detected gas temperature Tg turns into the temperature To which catalytic reaction stops, it can progress to processing of step S4.

[0065] Or even if it presumes the temperature of a catalyst from the temperature of the refrigerant of the heat exchange machine which cools the reforming machine 11 and a combustor 13, it can judge similarly.

[0066] Next, in step S4, the opening of flow control valves 8, 9, and 10 is decided to become an air flow rate required since the power which the auxiliary machinery drive of an automobile takes in the maintenance of temperature to which the catalyst of the reforming machine 11 which is needed at the time of a system startup, and a combustor 13 reacts, and the body 12 of a fuel cell according to the outside air temperature which detected the outside air temperature at the time of a generation-of-electrical-energy halt, and was detected at step S5 with the temperature sensor (outside-air-temperature detection means) 200 is generated.

[0067] The opening of a flow control valve approaches to 0% (close by-pass bulb completely) as the opening of a flow control valve becomes 100% (full open) as an air flow rate required at the time of a system startup is needed so in large quantities that outside air temperature is low temperature, the relation between outside air temperature and flow-control-valve opening becomes a thing as shown in the map of drawing 6 and outside air temperature becomes low, and an OAT becomes high. However, it is not made a close by-pass bulb completely a sake [ at the time of the next starting ], but predetermined opening is regulated as the minimum opening like drawing 6 .

[0068] And in step S6, flow control valves 8, 9, and 10 are opened to the opening determined at the above-mentioned step S5, and generation-of-electrical-energy halt processing is ended. In addition, the opening of the flow control valves 8, 9, and 10 which open at step S6 may not be based on outside air temperature, but constant value is sufficient as it. Moreover, when a system-wide control power source is intercepted compulsorily, flow control valves 8, 9, and 10 will be in a valve-opening condition mechanically.

[0069] By the above generation-of-electrical-energy halt processing, each flow control valves 8, 9, and 10 are closed with a halt of a generation of electrical energy, and the catalytic reaction of the reforming machine 11 or a combustor 13 is stopped. And if it judges that catalytic reaction stopped based on the temperature of each catalyst detected directly or indirectly etc., each flow control valves 8, 9, and 10 will be opened by the opening according to the outside air temperature at the time of a generation-of-electrical-energy halt.

[0070] Therefore, since each flow control valve is opened during the period of a generation-of-electrical-energy halt Since the passage of air is secured even if it is the case where a flow control valve froze and fixes after a generation-of-electrical-energy halt by the case where outside air temperature is low etc., at the time of the next starting Starting of a system can be attained in a short time, the time

amount which dissolves ice can become unnecessary like said conventional example, and the warm-up time of a fuel cell system can be shortened.

[0071] Next, the flow chart at the time of a system startup is shown in drawing 7.

[0072] First, the compressor 3 which is an air supply means is started at step S11, and the air of elevated-temperature high pressure is supplied to passage.

[0073] Step S In 12 and 13, freezing of the air flow control valves 8, 9, and 10 and fixing detection are performed. The air flow control valves 8, 9, and 10 have an opening sensor (opening detection means) or a current sensor (current detection means), and whether a drive command is followed from a control unit 100 detects the existence of freezing or fixing.

[0074] That is, a control unit 100 sends out a command value with a different value (opening) of at least two kinds of A1 and A2 as shown in drawing 8 to each flow control valves 8, 9, and 10.

[0075] And a judgment of freezing and fixing is made by whether there are one or more suitable outputs (response) from the opening sensor of each flow control valve to these opening command values. In the case where one or more suitable outputs cannot be found, these flow control valves 8, 9, and 10 are judged to be what has frozen thru/or fixed. Passing the air supplied from a compressor 3, progressing to step S14 and maintaining the present opening (set point at the time of a generation-of-electrical-energy halt) is continued. Freezing of flow control valves 8, 9, and 10 is dissolved with the elevated-temperature air supplied at the same time it continues operation preparation of the reforming machine 11, the body 12 of a fuel cell, and a combustor 13. And after predetermined time progress, it returns to step S12 again, freezing of flow control valves 8, 9, and 10 and fixing detection actuation are performed, and the same judgment as the above is made.

[0076] In addition, at step S14, as a result of detecting by repeating a predetermined count, when a suitable output is not obtained, it is judged as failure of flow control valves 8, 9, and 10.

[0077] on the other hand, at step S13, when there are one or more suitable outputs from the opening sensor of each flow control valve etc., flow control valves 8, 9, and 10 are not frozen -- it is -- it is -- it is judged as what was dissolved, it progresses to step S15, and the control at the time of operation is usually started.

[0078] In addition, what is necessary is just to detect freezing or fixing, when the current of each flow control valve exceeds a predetermined value to the above-mentioned opening command values A1 and A2 in detecting freezing by the current sensor.

[0079] By the above, at the time of starting of a fuel cell system When detecting whether each flow control valves 8, 9, and 10 have frozen or fixed and having frozen or fixed it It can start by the opening according to the OAT set up at the time of a generation-of-electrical-energy halt, and the air of the elevated-temperature high pressure in this opening is supplied to each flow control valves 8, 9, and 10, and icy fusion can be promoted. Like said conventional example After canceling freezing or fixing, the time amount which starting takes as compared with what starts a system can be shortened.

[0080] Moreover, since starting of a fuel cell system can be ensured immediately and the start up of a car becomes possible even if it is the case where it freezes, since each flow control valves 8, 9, and 10 are opened according to the outside air temperature at the time of a generation-of-electrical-energy halt, the practicality of the car equipped with the fuel cell system is improvable.

[0081] While drawing 9 shows the case where this invention is applied to other fuel cell systems and the above-mentioned reforming machine 11 is deleted, it is what formed the hydrogen bomb 15, and a flow control valve 10 controls the flow rate of hydrogen.

[0082] In this case, the same operation effectiveness as the above can be acquired that what is necessary is to wait for the catalytic reaction of a combustor 13 to stop each flow control valves 8, 9, and 10 determined at the time of a generation-of-electrical-energy halt since catalyzed combustion is performed by only the combustor 13, and just to open to the opening according to outside air temperature, or constant value.

[0083] In addition, what is necessary is to set up beforehand the graph of above-mentioned drawing 3 - drawing 5 by experiment etc., and just to store it in the control unit 100 beforehand as a map or a table.

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**DESCRIPTION OF DRAWINGS**

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**[Brief Description of the Drawings]**

[Drawing 1] The outline block diagram of the fuel cell system in which 1 operation gestalt of this invention is shown.

[Drawing 2] The flow chart which shows an example of the generation-of-electrical-energy halt processing performed by the control unit.

[Drawing 3] The graph which shows the relation of the time amount to a catalytic-reaction halt according to the temperature of the catalyst at the time of a generation-of-electrical-energy halt.

[Drawing 4] The graph which shows the amount of generations of electrical energy in front of a generation-of-electrical-energy halt, and the relation of whenever [ catalyst temperature ].

[Drawing 5] The graph which shows the relation between gas temperature and whenever [ catalyst temperature ].

[Drawing 6] The map in which the opening of a flow control valve according to an OAT is shown.

[Drawing 7] The flow chart which shows an example of the starting processing performed by the control unit.

[Drawing 8] The drive pattern for detecting freezing or fixing of a flow control valve is shown, and the relation between time amount and opening is shown.

[Drawing 9] The outline block diagram showing other gestalten of a fuel cell system.

**[Description of Notations]**

1 Air Filter

2 Air Flow Meter

3 Compressor

4 Compressor Drive Motor

5-7 Air flow meter

8-10 Flow control valve

11 Reforming Machine

12 Body of Fuel Cell

13 Combustor

14 Muffler (Silencer)

100 Control Unit

200-202 Temperature sensor

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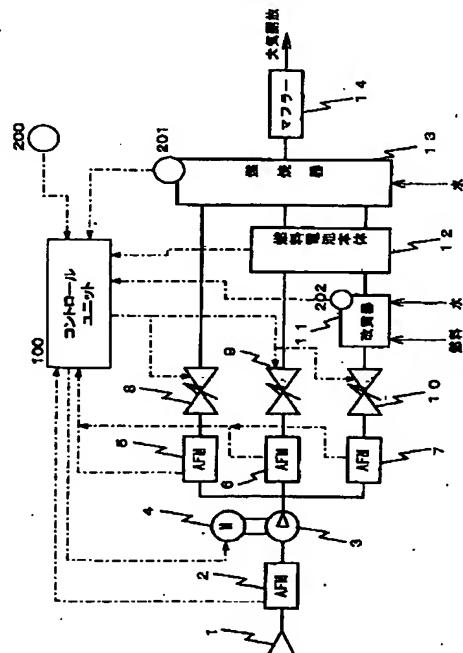
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(54)【発明の名称】 燃料電池システム

(57)【要約】

【課題】 空気流量制御手段の凍結・固着時においても起動時間を短縮可能な燃料電池システムを提供する。

【解決手段】 改質器11が生成した改質ガスと空気供給手段から供給する空気とから発電する燃料電池本体12と、燃料電池本体12が排出する排気ガスを空気供給手段から空気の供給を受けて触媒燃焼する燃焼器13と、空気供給手段が改質器11と燃料電池本体12及び燃焼器13に供給する空気の流量を流路の開度を変化させ制御する流量制御弁8～10と、燃料電池本体12の発電を停止する際には、発電停止直後に流量制御弁8～10を閉弁し、その後に所定条件が成立すると流量制御弁8～10を開弁させる。



## 【特許請求の範囲】

【請求項1】原燃料を改質触媒下で改質反応によって水素リッチな改質ガスを生成する燃料改質手段と、該燃料改質手段が生成した改質ガスと空気供給手段から供給する空気とから発電する発電手段と、発電手段が排出する排気ガスを空気供給手段から空気の供給を受けて触媒燃焼する燃焼手段と、空気供給手段が燃料改質手段と発電手段及び燃焼手段に供給する空気の流量を流路の開度を変化させ制御する空気流量制御手段と、前記発電手段の発電を停止する際には、発電停止直後に前記空気流量制御手段を閉弁し、その後に所定条件が成立すると空気流量制御手段を開弁させる発電停止時制御手段とを備えたことを特徴とする燃料電池システム。

【請求項2】水素貯蔵手段が供給する水素ガスと空気供給手段から供給する空気とから発電する発電手段と、発電手段が排出する排気ガスを空気供給手段から空気の供給を受けて触媒燃焼する燃焼手段と、空気供給手段が燃料改質手段と発電手段及び燃焼手段に供給する空気の流量を流路の開度を変化させ制御する空気流量制御手段と、

前記発電手段の発電を停止する際には、発電停止直後に前記空気流量制御手段を閉弁し、その後に所定条件が成立すると空気流量制御手段を開弁させる発電停止時制御手段とを備えたことを特徴とする燃料電池システム。

【請求項3】前記発電停止時制御手段は、発電停止の後に触媒が反応しなくなる温度に低下するまでの時間が経過したことから所定条件の成立を判定することを特徴とする請求項1または2に記載の燃料電池システム。

【請求項4】前記発電停止時制御手段は、発電停止直前における予め設定した時間内の発電手段での発電量が大きいほど、空気流量制御手段の閉弁期間を長くすることを特徴とする請求項1または2に記載の燃料電池システム。

【請求項5】前記発電停止時制御手段は、燃料改質手段及び燃焼手段のうち、少なくとも一方の温度を検出する検出手段を有し、発電停止後に検出した前記温度が所定値まで下がったことを所定条件の成立として、上記流量制御手段を開弁することを特徴とする請求項1または請求項2に記載の燃料電池システム。

【請求項6】前記所定条件の成立は、温度検出手段の検出温度が触媒反応が停止する温度であることを特徴とする請求項5に記載の燃料電池システム。

【請求項7】前記温度検出手段は、前記燃料改質手段の改質触媒または燃焼手段の燃焼触媒の温度を検出することを特徴とする請求項5に記載の燃料電池システム。

【請求項8】前記温度検出手段は、触媒における空気または燃焼ガスの温度に基づいて触媒の温度を推定することを特徴とする請求項5に記載の燃料電池システム。

【請求項9】前記温度検出手段は、触媒の熱交換器の冷

媒の温度を検出し、この冷媒の温度に基づいて触媒の温度を推定することを特徴とする請求項5に記載の燃料電池システム。

【請求項10】前記温度検出手段は、触媒の容器温度を検出し、検出した温度に基づいて触媒の温度を推定することを特徴とする請求項5に記載の燃料電池システム。

【請求項11】前記発電停止時制御手段は、所定条件成立後に、空気流量制御手段を開弁させる開度を、システム起動時に必要な空気流量に応じて設定する開度設定手段を有することを特徴とする請求項1または2に記載の燃料電池システム。

【請求項12】前記開度設定手段は、空気流量制御手段の開度を、前記触媒が反応する温度の維持及び発電手段において自動車の補機駆動に要する電力発生に必要な空気流量を流す値に設定することを特徴とする請求項11に記載の燃料電池システム。

【請求項13】前記開度設定手段は、外気温度を検出する外気温度検出手段を有し、発電停止時の外気温度が低いほど、前記空気流量制御手段の開度を大きく設定することを特徴とする請求項11または請求項12に記載の燃料電池システム。

【請求項14】前記空気流量制御手段は、システム起動時に凍結が検出された場合は、発電停止後に設定された開度を維持する凍結検出手段を有することを特徴とする請求項1または2に記載の燃料電池システム。

【請求項15】前記空気流量制御手段は、システム起動時に凍結が検出されない場合、または、凍結状態が解消した場合には、開度の制御を通常運転時の制御へ移行することを特徴とする請求項14に記載の燃料電池システム。

【請求項16】前記凍結検出手段は、弁の開度を検出する開度検出手段を有し、空気流量制御手段への指令値と、開度検出手段により検出された空気流量制御手段の開度を比較することにより、空気流量制御手段の凍結の有無を検出することを特徴とする請求項14に記載の燃料電池システム。

【請求項17】前記凍結検出手段は、空気流量制御手段へ供給される電流を検出する電流検出手段を有し、該空気流量制御手段への指令値と、電流検出手段により検出された電流値とを比較することにより、空気流量制御手段の凍結の有無を検出することを特徴とする、請求項14に記載の燃料電池システム。

【請求項18】前記凍結検出手段は、少なくとも2種類の異なる開度指令値を指令することを特徴とする請求項16または請求項17に記載の燃料電池システム。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、車両用燃料電池システムの改良に関するものである。

【0002】

【従来の技術】燃料電池システムを停止状態で0°C以下の低温雰囲気に放置し、空気に含まれる水分により空気流量制御手段（バルブ）が凍結し固着した場合、起動時に氷を溶解してから空気流量制御手段を可動状態にすることが必要となる。この手段として、従来は空気供給手段であるコンプレッサ等を用いて供給される高温ガスにより、システムの温度を上昇させる方法（特開2000-12060号公報、特開平5-131131号公報）などが提案されている。

【0003】

【発明が解決しようとする課題】しかしながら、上記従来例のように空気供給手段から供給される高温な空気によりシステムの温度を上昇させて空気流量制御手段の解凍を行う方法は、氷の溶解までに時間がかかるため、システム起動時間が長くなるという問題があった。

【0004】また、通常発電停止時には空気流量制御手段が全閉状態を維持するため、凍結して固着した場合、空気供給手段から供給される空気が空気流量制御手段より下流に位置する装置に行き渡らないため、さらにシステム起動時間が長くなるという問題もある。

【0005】また、一般に加熱器や電熱器を用いて氷を溶解させる方法も考えられるが、この場合では、システムが複雑になる上にバッテリー等付属のエネルギーを使用する必要があった。

【0006】そこで、本発明は上記問題点に鑑みてなされたもので、空気流量制御手段の凍結・固着時においても起動時間を短縮可能な燃料電池システムを提供することを目的とする。

【0007】

【課題を解決するための手段】第1の発明は、原燃料を改質触媒下で改質反応によって水素リッチな改質ガスを生成する燃料改質手段と、該燃料改質手段が生成した改質ガスと空気供給手段から供給する空気とから発電する発電手段と、発電手段が排出する排気ガスを空気供給手段から空気の供給を受けて触媒燃焼する燃焼手段と、空気供給手段が燃料改質手段と発電手段及び燃焼手段に供給する空気の流量を流路の開度を変化させ制御する空気流量制御手段と、前記発電手段の発電を停止する際には、発電停止直後に前記空気流量制御手段を閉弁し、その後に所定条件が成立すると空気流量制御手段を開弁させる発電停止時制御手段とを備える。

【0008】また、第2の発明は、水素貯蔵手段が供給する水素ガスと空気供給手段から供給する空気とから発電する発電手段と、発電手段が排出する排気ガスを空気供給手段から空気の供給を受けて触媒燃焼する燃焼手段と、空気供給手段が燃料改質手段と発電手段及び燃焼手段に供給する空気の流量を流路の開度を変化させ制御する空気流量制御手段と、前記発電手段の発電を停止する際には、発電停止直後に前記空気流量制御手段を閉弁し、その後に所定条件が成立すると空気流量制御手段を

開弁させる発電停止時制御手段とを備える。

【0009】また、第3の発明は、前記第1または第2の発明において、前記発電停止時制御手段は、発電停止の後に触媒が反応しなくなる温度に低下するまでの時間が経過したことから所定条件の成立を判定する。

【0010】なお、前記触媒は燃料改質手段、燃焼手段の少なくとも一方を有する。

【0011】また、第4の発明は、前記第1または第2の発明において、前記発電停止時制御手段は、発電停止直前における予め設定した時間内の発電手段での発電量

10 が大きいほど、空気流量制御手段の閉弁期間を長くする。

【0012】また、第5の発明は、前記第1または第2の発明において、前記発電停止時制御手段は、燃料改質手段及び燃焼手段のうち、少なくとも一方の温度を検出する検出手段を有し、発電停止後に検出した温度が所定値まで下がったことを所定条件の成立として、上記流量制御手段を開弁する。

【0013】また、第6の発明は、前記第5の発明において、前記所定条件の成立は、温度検出手段の検出温度が燃料改質手段及び燃焼手段の触媒反応が停止する温度である。

【0014】また、第7の発明は、前記第5の発明において、前記温度検出手段は、前記燃料改質手段の改質触媒または燃焼手段の燃焼触媒の温度を検出する。

【0015】また、第8の発明は、前記第5の発明において、前記温度検出手段は、触媒における空気または燃焼ガスの温度に基づいて触媒の温度を推定する。

【0016】また、第9の発明は、前記第5の発明において、前記温度検出手段は、触媒の熱交換器の冷媒の温度を検出し、この冷媒の温度に基づいて触媒の温度を推定する。

【0017】また、第10の発明は、前記第5の発明において、前記温度検出手段は、触媒の容器温度を検出し、検出した温度に基づいて触媒の温度を推定する。

【0018】また、第11の発明は、前記第1または第2の発明において、前記発電停止時制御手段は、所定条件成立後に、空気流量制御手段を開弁させる開度を、システム起動時に必要な空気流量に応じて設定する開度設定手段を有する。

【0019】また、第12の発明は、前記第11の発明において、前記開度設定手段は、空気流量制御手段の開度を、前記触媒が反応する温度の維持及び発電手段において自動車の補機駆動に要する電力発生に必要な空気流量を流す値に設定する。

【0020】また、第13の発明は、前記第11または第12の発明において、前記開度設定手段は、外気温度を検出する外気温度検出手段を有し、発電停止時の外気温度が低いほど、前記空気流量制御手段の開度を大きく設定する。

【0021】また、第14の発明は、前記第1または第2の発明において、前記空気流量制御手段は、システム起動時に凍結が検出された場合は、発電停止後に設定された開度を維持する凍結検出手段を有する。

【0022】また、第15の発明は、前記第14の発明において、前記空気流量制御手段は、システム起動時に凍結が検出されない場合、または、凍結状態が解消した場合には、開度の制御を通常運転時の制御へ移行する。

【0023】また、第16の発明は、前記第14の発明において、前記凍結検出手段は、弁の開度を検出手する開度検出手段を有し、空気流量制御手段への指令値と、開度検出手段により検出された空気流量制御手段の開度を比較することにより、空気流量制御手段の凍結の有無を検出する。

【0024】また、第17の発明は、前記第14の発明において、前記凍結検出手段は、空気流量制御手段へ供給される電流を検出手する電流検出手段を有し、該空気流量制御手段への指令値と、電流検出手段により検出された電流値とを比較することにより、空気流量制御手段の凍結の有無を検出する。

【0025】また、第18の発明は、前記第16または第17の発明において、前記凍結検出手段は、少なくとも2種類の異なった開度指令値を指令する。

【0026】

【発明の効果】したがって、第1または第2の発明によれば、発電停止直後は空気流量制御手段を閉弁するので、燃料改質手段及び発電手段への空気の供給が遮断され、触媒反応が停止し確実にシステム全体を停止することが出来る。

【0027】その後、所定の条件が成立すると、空気流量制御手段を開弁しておくので、発電停止後に流量制御手段が凍結して固着した場合にも、空気の流路は確保されている。この開弁によって、次の起動時には、凍結の有無に関わらず短時間でシステムの起動が可能となる。

【0028】また、第3の発明は、事前に実験等で求めた触媒が反応しなくなるまでの時間とすることによって、新たにセンサなどを増やすこと必要がなく、装置を簡易に構成できる。

【0029】また、第4の発明は、発電手段での発電量が大きい場合、触媒（燃料改質手段及び燃焼手段）の温度も高温になるため、発電停止直前の予め設定した時間における発電手段の発電量が大きい場合には、空気流量制御手段を開弁するまでの時間を長くするので、燃料改質手段及び燃焼手段の触媒がまだ反応する温度である間に空気流量制御手段を開弁することを防ぐことができる。

【0030】また、第5の発明によれば、燃料改質手段及び燃焼手段のうち、少なくとも一方の検出温度が所定値まで下がった後、空気流量制御手段を開弁することが

できるので、精密な制御ができる。

【0031】また、第6の発明は、空気流量制御手段を開弁する所定の温度は触媒（燃料改質手段及び燃焼手段）が反応しなくなる温度とするので、空気流量制御手段を開弁した後に空気が流入しても燃料電池システムを確実に停止することが出来る。

【0032】また、第7の発明は、燃料改質手段の改質触媒または燃焼手段の燃焼触媒の温度を検出することで、所定条件の成立を判定できる。

10 【0033】また、第8の発明は、燃料改質手段及び燃焼手段における改質ガス、燃焼ガスの温度を直接検出し、この温度から触媒の温度を推定することで所定条件の成立を判定できる。

【0034】また、第9の発明は、燃料改質手段及び燃焼手段などの触媒の熱交換器の冷媒温度を検出することで、所定条件の成立を判定できる。特に、冷媒温度は触媒の温度よりも低温であるため簡易な検出手段にて温度を検出することが出来る。

20 【0035】また、第10の発明は、触媒（燃料改質手段及び燃焼手段）における容器の温度を検出することで、所定条件の成立を判定できる。特に、容器表面の温度を検出するために容器本体等に大きな変更を加えることなく簡便な方法で温度を検出することが出来る。

【0036】また、第11または第12の発明によれば上記所定条件成立後、空気流量制御手段を開弁させる際に、燃料改質手段及び燃焼手段の触媒の反応が維持でき、また自動車の各補機類を駆動するに必要な電力を発電手段にて発電できる開度となるよう制御することにより、次のシステム起動時に空気流量制御手段が凍結、

30 固着していた場合であっても空気供給手段が供給する空気の流路を確保出来るため、燃料電池システムを確実に起動することが出来、その上凍結した流量制御手段を解凍することが出来る。

【0037】また、第13の発明は、システム停止時の外気温が低いほど空気流量制御手段の開度を大きく設定するため、次のシステム起動時に空気流量制御手段が凍結していた場合でも、短時間でシステムを起動することができ、凍結した空気流量制御手段の溶解も速やかにできる。

40 【0038】また、第14の発明は、空気流量制御手段は凍結検出手段を有し、起動時に凍結が検出された場合には前回システム停止後に設定された開度を維持するため、凍結、固着した空気流量制御手段を無理に動かすことを避けることが出来る。

【0039】また、第15の発明によれば空気流量制御手段の凍結が溶解した場合、通常運転時の制御に復帰するため、燃料改質手段及び発電手段で効率良い改質反応及び発電を行うことが出来る。

50 【0040】また、第16の発明は、空気流量制御手段は開度検出手段を有し、入力される開度指令値とその時

の開度を比較することにより、凍結の有無を確認することが出来る。

【0041】また、第17の発明は、空気流量制御手段は電流検出手段を有し、入力される開度指令値とその時の電流を比較することにより、凍結の有無を確認することが出来る。

【0042】また、第18の発明によれば、凍結検出手段の指令値は1回の検知動作につき少なくとも2種類の異なる指令値にて凍結検知を実施するため、流量制御手段の開度と、1つの指令値の開度が同一であった場合でも他の指令値によって凍結検知を確実に行うことが出来る。

【0043】

【発明の実施の形態】以下、本発明の一実施形態を添付図面に基づいて説明する。

【0044】図1は、本発明の第1の実施の形態を示す概略構成図である。

【0045】図1において、1はエアフィルタ、2及び5~7はエアフローメータ、3はコンプレッサ、4はコンプレッサ駆動モータ、8~10は流量制御弁、11は改質器、12は燃料電池本体、13は燃焼器、14はマフラー（消音器）である。

【0046】また、図1においてエアフィルタ1からコンプレッサ駆動モータ4が空気供給手段を構成し、エアフローメータ5と流量制御弁8、エアフローメータ6と流量制御弁9、エアフローメータ7と流量制御弁10が、それぞれを空気流量制御手段を構成する。

【0047】流量制御弁10の下流には原燃料の改質を行う改質器（燃料改質手段）11が設けられ、この改質器11及び流量制御弁9の下流には発電手段としての燃料電池本体12が配設されている。

【0048】そして、燃料電池本体12及び流量制御弁8の下流には燃焼手段としての燃焼器13が設けられ、燃焼器13で発生した排気はマフラー14を介して大気開放される。

【0049】空気供給手段は、エアフィルター1にて清浄された空気をエアフローメータ5にて流量を検出した後、コンプレッサ3の吐出量が所望の流量となるようコンプレッサ駆動モータ4を制御している。

【0050】空気流量制御手段は、改質器11、燃料電池本体12、燃焼器13への流路にそれぞれに設けられており、エアフローメータ5、6、7にて検出した流量から所望の下流側流量となるように流量制御弁8、9、10の開度を変更し、改質器11、燃料電池本体12、燃焼器13へ供給する空気流量を制御している。

【0051】改質器11は、図示しないタンク等からメタノールやガソリンといった炭化水素系燃料（原燃料）と水及び空気供給手段から供給される空気を用いて、改質触媒にて改質反応を起こし、H<sub>2</sub>とCOの混合ガスを生成する。COは燃料電池本体12の白金電極を被毒さ

せ燃料電池本体の性能を著しく低下させることから、改質器11は選択酸化反応等手段を用いて混合ガス中のCO除去を行い、水素リッチな改質ガスを生成する装置も備えている。

【0052】燃料電池本体12は改質器11で生成される改質ガスを燃料極に供給され、空気供給手段から供給される空気と反応して発電を行う。

【0053】燃焼器13は、燃料電池本体12から排出される反応後の改質ガスと空気を触媒にて酸化させ、大気への放出可能な水蒸気等物質へ変化させる。

【0054】流量制御弁8~10は、コントロールユニット100によって制御される。コントロールユニット100は、温度センサ200が検出した外気温度や、温度センサ201が検出した燃焼器の温度、温度センサ202が検出した改質器11の温度、エアフローメータ2、5、6、7が検出した空気流量、燃料電池本体12の発電量などに基づいて、各流量制御弁8、9、10の開度を決定し、駆動する。

【0055】図2のフローチャートは、コントロールユニット100で行われる流量制御弁制御の一例を示し、燃料電池システムの停止時に実行されるものである。

【0056】まず、ステップS1にて発電停止信号等の入力により発電停止の処理を開始する。

【0057】ステップS2では、改質器11、燃料電池12及び燃焼器13への空気供給を停止して各反応を停止するために、流量制御弁8、9、10をそれぞれ閉弁させる。

【0058】次にステップS3では、改質器11及び燃焼器13の触媒が反応しなくなる温度に達したか否か（所定条件の成立）を判断する。

【0059】これら、触媒の反応が停止する温度の検出は、上記温度センサ201、202が検出した温度を用いることができ、温度センサ201、202の検出した温度がそれぞれ所定値以下になれば、触媒反応が停止したと判断してステップS4の処理へ進む。

【0060】この触媒反応停止の判断としては、上記のように触媒の温度を直接検出するものの他、間接的に検出または推定した値に基づいて行ってもよい。

【0061】例えば、図3は、発電停止から改質器11または燃焼器13の触媒が反応を停止するまでの時間t<sub>0</sub>と、触媒温度の関係を示したものである。触媒が反応しなくなる温度T<sub>0</sub>以下となりうる経過時間t<sub>0</sub>を、検出した改質器11や燃焼器13の温度に基づいてこのグラフ等から算出する。この場合、ステップS3では時間t<sub>0</sub>が経過するのをタイマーなどで監視し、この経過時間t<sub>0</sub>が経過した時点で、触媒反応が停止したと見なしてステップS4の処理へ進む。

【0062】あるいは、図4は発電停止直前の予め決められた時間内における燃料電池本体12での発電量Wと改質器11及び燃焼器13の触媒温度の関係を示したもの

のである。

【0063】この場合では、検出した燃料電池本体12の発電量Wから触媒温度T<sub>0</sub>を決め、上記図4のグラフから触媒温度T<sub>0</sub>に応じた時間t<sub>0</sub>を求め、ステップS3では時間t<sub>0</sub>が経過するのをタイマーなどで監視し、この経過時間t<sub>0</sub>が経過した時点で、触媒反応が停止したと見なしてステップS4の処理へ進む。これにより、改質器11や燃焼器13の温度を直接検出することなく制御を行うことができる。なお、発電停止直前における予め設定した時間内の発電量が大きいほど、流量制御弁を開弁させて触媒反応の停止を待つ期間（時間）は長くなる。

【0064】この他、温度センサ202で改質器11内の改質ガス温度を検出し、温度センサ201で燃焼器13内の燃焼ガスの温度を検出するようにしてもよく、この場合は、図5に示すような検出した各ガスの温度T<sub>g</sub>と触媒温度T<sub>0</sub>の関係を用いて触媒の温度を推定する。そして、検出したガス温度T<sub>g</sub>が、触媒反応が停止する温度T<sub>0</sub>になった時点で、ステップS4の処理へ進むことができる。

【0065】あるいは、改質器11及び燃焼器13を冷却する熱交換機の冷媒の温度から触媒の温度を推定しても、同様に判断することができる。

【0066】次にステップS4では、温度センサ（外気温検出手段）200によって発電停止時の外気温を検出し、ステップS5で検出した外気温によってシステム起動時に必要となる、改質器11及び燃焼器13の触媒が反応する温度の維持、及び燃料電池本体12において自動車の補機駆動に要する電力を発生するために必要な空気流量となるよう流量制御弁8、9、10の開度を決めらる。

【0067】システム起動時に必要な空気流量は、外気温が低温であるほど大量に必要となり、外気温と流量制御弁開度の関係は図6のマップに示すようなものとなり、外気温が低くなるにつれて流量制御弁の開度は100%（全開）になり、外気温度が高くなるにつれて流量制御弁の開度は0%（全閉）に近づく。ただし、次の起動時のために全閉にはせず、図6のように所定の開度を最小開度として規制する。

【0068】そして、ステップS6において、上記ステップS5で決定した開度に流量制御弁8、9、10を開き、発電停止処理を終了する。なお、ステップS6で開弁する流量制御弁8、9、10の開度は外気温によらず、一定値でも構わない。また、システム全体の制御電源が強制的に遮断された場合には、機械的に流量制御弁8、9、10は開弁状態となる。

【0069】以上の発電停止処理によって、発電の停止に伴って各流量制御弁8、9、10を開弁して改質器11または燃焼器13の触媒反応を停止させる。そして、直接あるいは間接的に検出した各触媒の温度等に基づい

て、触媒反応が停止したと判断すると、発電停止時の外気温に応じた開度で各流量制御弁8、9、10を開いておく。

【0070】したがって、発電停止の期間中は各流量制御弁を開弁しておくので、外気温が低い場合などで、発電停止後に流量制御弁が凍結して固着した場合であっても、空気の流路は確保されているので、次の起動時には、短時間でシステムの起動が可能となり、前記従来例のように、氷を融解する時間が不要となって、燃料電池

10 システムの起動時間を短縮することができる。

【0071】次に、図7にシステム起動時のフローチャートを示す。

【0072】まず、ステップS11にて空気供給手段であるコンプレッサ3を起動し、高温高圧の空気を流路に供給する。

【0073】ステップS12、13では、空気流量制御弁8、9、10の凍結、固着検知を行う。空気流量制御弁8、9、10は開度センサ（開度検出手段）または電流センサ（電流検出手段）を有し、コントロールユニット100からの駆動指令に応動するか否かによって、凍結または固着の有無を検出する。

【0074】すなわち、コントロールユニット100は、図8に示すような少なくとも2種類のA1、A2という異なる値（開度）を持つ指令値を各流量制御弁8、9、10へ送出する。

【0075】そして、これらの開度指令値に対し各流量制御弁の開度センサから1つ以上の適切な出力（応答）があるか否かで凍結、固着の判断を行う。1つ以上の適切な出力が無かった場合では、これら流量制御弁8、9、10は凍結ないし固着しているものと判断し、ステップS14に進んで現状の開度（発電停止時の設定値）を維持したままコンプレッサ3から供給される空気を流し続け、改質器11、燃料電池本体12、燃焼器13の運転準備を続けると同時に、供給される高温空気によって流量制御弁8、9、10の凍結を溶解する。そして、所定時間経過後、再度ステップS12へ戻って、流量制御弁8、9、10の凍結、固着検知動作を行い、上記と同様の判断を行う。

【0076】なお、ステップS14では、所定の回数を繰返して検知を行った結果、適切な出力が得られない場合は流量制御弁8、9、10の故障と判断する。

【0077】一方、ステップS13では、各流量制御弁の開度センサなどから1つ以上の適切な出力があった場合には、流量制御弁8、9、10は凍結していないあるいは溶解したものと判断し、ステップS15に進んで通常運転時の制御を開始する。

【0078】なお、凍結の検出を電流センサで行う場合には、上記開度指令値A1、A2に対して各流量制御弁の電流が所定値を越えたときに凍結または固着を検出すればよい。

【0079】以上により、燃料電池システムの起動時には、各流量制御弁8、9、10が凍結または固着しているか否かを検出し、凍結または固着している場合には、発電停止時に設定した外気温度に応じた開度で起動することができ、この開度で高温高圧の空気を各流量制御弁8、9、10へ供給して氷の融解を促進でき、前記従来例のように、凍結または固着を解消してからシステムの起動を行うものに比して起動に要する時間を短縮できるのである。

【0080】また、各流量制御弁8、9、10は発電停止時の外気温に応じて開いているため、凍結した場合であっても、確実に燃料電池システムの起動を即座に行うことができ、車両の運転開始が可能になるので、燃料電池システムを備えた車両の実用性を改善することができるるのである。

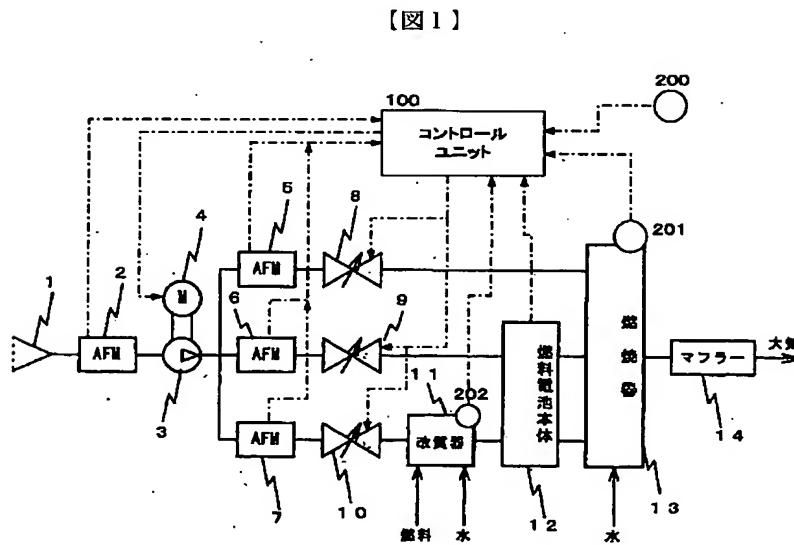
【0081】図9は、他の燃料電池システムに本発明を適用した場合を示し、上記改質器11を削除する一方、水素ポンベ15を設けたもので、流量制御弁10は水素の流量を制御する。

【0082】この場合では、触媒燃焼は燃焼器13のみで行われるため、発電停止時に決定する各流量制御弁8、9、10は、燃焼器13の触媒反応が停止するのを待って外気温に応じた開度あるいは一定値まで開けばよく、上記と同様の作用効果を得ることができる。

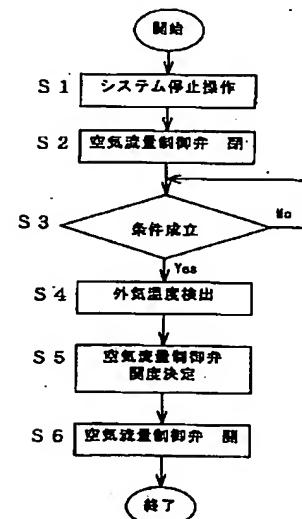
【0083】なお、上記図3～図5のグラフは、実験などにより予め設定しておき、マップあるいはテーブルとして予めコントロールユニット100に格納しておけばよい。

#### 【図面の簡単な説明】

【図1】本発明の一実施形態を示す燃料電池システムの\*30



【図2】



#### \* 概略構成図。

【図2】コントロールユニットで行われる発電停止処理の一例を示すフローチャート。

【図3】発電停止時の触媒の温度に応じた触媒反応停止までの時間の関係を示すグラフ。

【図4】発電停止直前の発電量と触媒温度の関係を示すグラフ。

【図5】ガス温度と触媒温度の関係を示すグラフ。

【図6】外気温度に応じた流量制御弁の開度を示すマップ。

【図7】コントロールユニットで行われる起動処理の一例を示すフローチャート。

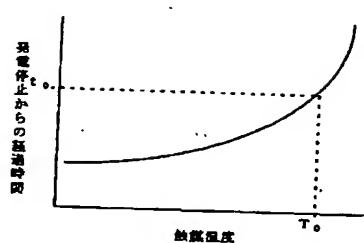
【図8】流量制御弁の凍結または固着を検出するための駆動パターンを示し、時間と開度の関係を示す。

【図9】燃料電池システムの他の形態を示す概略構成図。

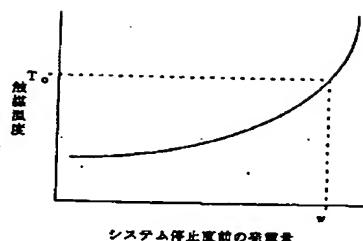
#### 【符号の説明】

1	エアフィルタ
2	エアフローメータ
3	コンプレッサ
4	コンプレッサ駆動モータ
5～7	エアフローメータ
8～10	流量制御弁
11	改質器
12	燃料電池本体
13	燃焼器
14	マフラー（消音器）
100	コントロールユニット
200～202	温度センサ

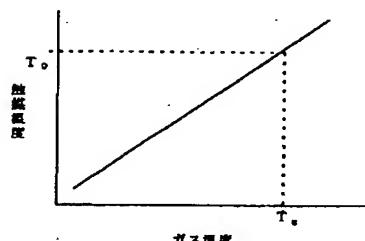
【図3】



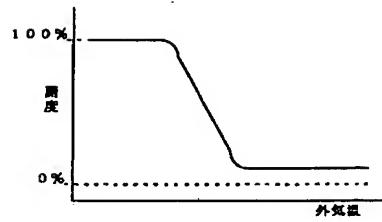
【図4】



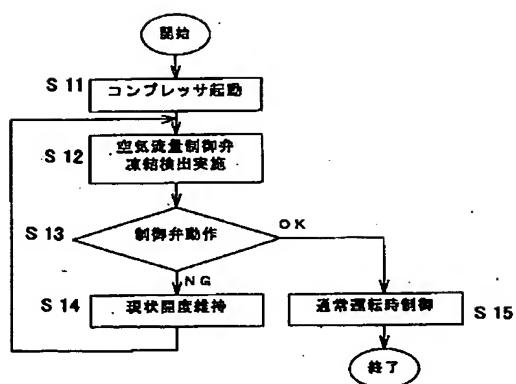
【図5】



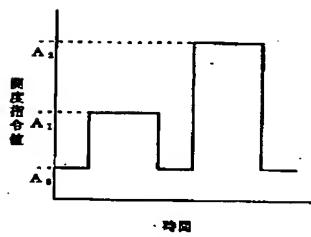
【図6】



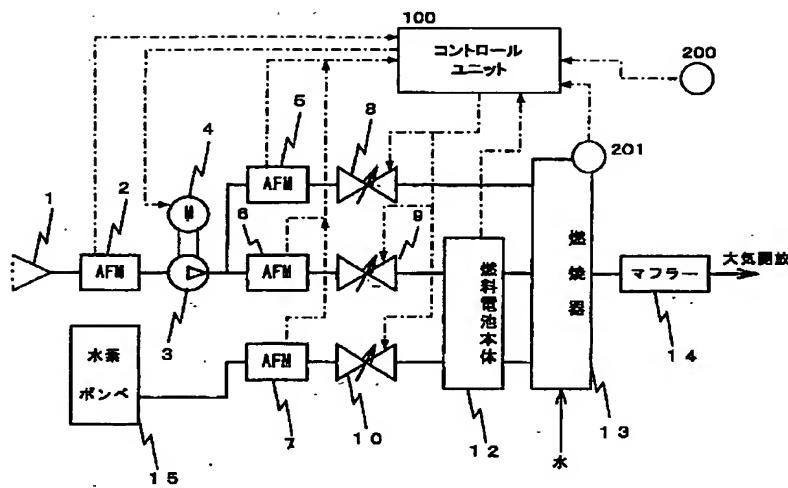
【図7】



【図8】



【図9】



フロントページの続き

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